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ABSTRACT

This report is based on a study of a few of the multidisciplinary environmental programs in over 30 universities. The study was undertaken to discover what kind of programs have been tried, which ones have been successful, and how the federal government might encourage effective interdisciplinary problem-focused programs. The report reviews the problems that universities encounter in organizing interdisciplinary environmental programs and recommends that the universities develop new administrative structures responsive to the complex nature of environmental problems. Two features are considered essential for problem-focused programs to be successful: (1) substantial or complete control of the faculty reward structure; and (2) freedom to be innovative in introducing course material, educational programs, work study programs, and curriculum requirements for degrees. The study indicates that federal funds being expended at universities for environmental problems do not encourage problem-focused multidisciplinary education and may even discourage such programs. A separate report included as an appendix, Federal Administration and Support of University Interdisciplinary Research, reviews the history of federal funding of interdisciplinary programs. (PR)

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THE UNIVERSITIES and ENVIRONMENTAL QUALITY

Commitment to Problem Focused Education

A Report to
The President's Environmental Quality Council

EXECUTIVE OFFICE OF THE PRESIDENT
Office of Science and Technology

September 1969

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THE UNIVERSITIES AND ENVIRONMENTAL QUALITY -- COMMITMENT TO PROBLEM FOCUSED EDUCATION

A REPORT TO

THE PRESIDENT'S ENVIRONMENTAL QUALITY COUNCIL

by

John S. Steinhart and Stacie Cherniack

Office of Science and Technology

Executive Office of the President

September 1969

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FOREWORD

The colleges and universities of the United States have contributed in many ways to the growth of our country and the solutions of its problems. Through the Land Grant College Act, Schools of Agriculture and Engineering, Schools of Public Health and the recent Sea Grant College Program we have found ways in this country to utilize our colleges and universities in realizing our national aims that are different from those found elsewhere in the world. The report concludes that there are many at the colleges and universities, both faculty and students, prepared to devote their efforts to the solution of the complex problems of environmental quality. I feel certain that this is the case. The question then becomes, in what way can we encourage them to join with the Federal Government and the society at large in seeking solutions to these problems?

While studying the existing programs described in the report the authors had an extensive discussion with students as well as faculty and administrators. The enthusiasm of the student participants is particularly interesting and suggests that there are many among the student generation who can employ their concerns about the future of our society in useful ways in programs of the sort described. One of the authors of the report is herself a student and the report illustrates the serious and cogent work such young people will do if given an opportunity.

I find particularly interesting the suggestions of interaction between universities and the Federal Agencies in a common goal to improve the quality of our environment. The importance of the goal recommends serious consideration of the report by everyone.

Lee A. DuBridge
Executive Secretary
Environmental Quality Council

THE UNIVERSITIES AND ENVIRONMENTAL QUALITY --

COMMITMENT TO PROBLEM FOCUSED EDUCATION

Highlights and Recommendations

Concern for the serious and complex problems of environmental degradation is constantly growing. All elements of our society share these apprehensions about the future. At the same time our national wealth, resources, and technological abilities should permit the nation to choose from an incredible variety of future options for the quality of our environment and the kind of life we live in it.

The colleges and universities of the nation constitute a powerful institutional resource for education, research and open discussion of our problems and opportunities. At present, except for the prophets of environmental disaster, little of this open discussion of our future environmental alternatives seems to take place at the colleges and universities. There is a national shortage of broadly trained professionals to deal with environmental problems. This report is a study of a few of the vigorous multidisciplinary programs at universities. The aim was to discover what kinds of programs have been tried, which ones have been successful, and how the federal government might encourage the promising efforts.

Extensive discussions were held with faculty, students, administrators and interested people from outside universities about multidisciplinary environmental programs. Detailed on-site studies were made of six programs. We found that there do exist some very exciting and promising programs. Many of these programs face opposition within the university and all lack a suitable funding mechanism. We conclude that two features are essential for such problem focused program to be successful, (although they alone cannot guarantee success):

1. Substantial or complete control of the faculty reward structure and

2. Freedom to be innovative in introducing course material, educational programs, work study programs, and curriculum requirements for degrees.

We found the student participants in these programs to be enthusiastic and absorbed in their work. An unexpected finding was that more than half the students in such problem focused programs have held jobs for some years and have returned to the university to seek out these multidisciplinary programs because their earlier university education did not satisfy their requirements. It is our feeling that problem focused programs of the sort we examined provide the opportunity many students seek for an education relevant to society's problems, yet thoroughly professional.

We found that federal funds being expended at universities for environmental problems do not encourage problem focused multi-disciplinary education and may even discourage the establishment of such programs. The appendix reviews the history of federal funding of interdisciplinary programs and we have concluded that new directions are required.

We have therefore recommended that the Federal Government assist in the formation at colleges and universities of Schools of the Human Environment answering the above criteria. Their common purpose should be problem focused education and research directed toward people's need and desire for satisfying life in pleasant surroundings. The historical example of schools of agriculture and schools of public health illustrate that such efforts are far from unprecedented. Initially such a program would cost approximately twenty million dollars, some of which could be transferred from existing programs. We recommend further that initial funding be done by an ad hoc group drawn from the interested mission agencies and the National Science Foundation and operate under the policy guidance of the President's Environmental Quality Council.

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Appendix:

Federal Administration and Support of University Interdisciplinary Research by D. E. Cunningham

THE UNIVERSITIES AND ENVIRONMENTAL QUALITY -- COMMITMENT TO PROBLEM FOCUSED EDUCATION

Introduction

We, as individual people, are immersed in our environment. We can change it but we can never escape it. We perceive it most often as physical and biological surroundings and, somewhat less well, as cultural and social surroundings. The growing public concern about the degradation of our physical environment and the hazards to our biological environment is obvious and will not be detailed further. Prophets of environmental disaster on every hand are quite ready to conduct us collectively or individually through a house of horrors of possibilities for the immediate or not very distant future. Many of the outcries of the young and of the minority groups relate to the environment and the quality of life as compared with what these groups intuitively feel are the possibilities for this country at this time. That the concern is much more widespread can be ascertained from the response of the stable middle part of society to such issues as the Santa Barbara oil spill, transportation of dangerous materials, or the use of pesticides.

A very serious risk is that we may follow some few of the traditionally-minded engineers and equate environmental quality with pollution abatement. If pollution were brought under control and clean air and clean water

became a reality it is doubtful that the malaise about the quality of life would disappear. In any case, a program based only upon taboos-- a program stating that "thou shalt not pollute"-- has very limited appeal among all the alternative futures that may possibly await us. We have intervened in the environment whether we wished to or not and our only real hopes lie in deciding how it is we wish to live and inquiring whether we can achieve it or not.

The case is summarized by Hans Gaffron, one of America's leading biologists, in a recent statement. "This restless urge to mold a world according to his, unfortunately quite limited, imagination - this force has pushed man himself into a corner from which he must now try to liberate himself. At the moment it looks as if stupidity and meanness, combined with the forces of technology, are going to win the race towards cultural extermination before reason has had a good chance to discover the best way to reverse the trend."

To end and reverse the degradation of our physical and biological environment, to identify the alternative future options open to our society, and to define the common elements of the kind of life to which our society aspires will require strenuous efforts by all the people and institutions of the American society. This report is a brief but intensive study of the contributions that can be made by one of these institutions - the colleges and universities of the United States.

Education has always played a central role in the American dream, and the many and varied uses we have made of our universities illustrate society's faith in education. Of all subjects, it is easiest to get firm and solid opinions concerning the education of the young from all members of society. It should be noted that within the next few years more than fifty percent of the nation's young people will attend colleges and universities at some time. If we are truly concerned about the quality of environment and quality of life this concern must be illustrated and participated in by our educational system.

It is patently obvious, but bears repeating, that the problems and opportunities related to our environm nt in a growing and increasingly technological society are multidisciplinary as viewed from the traditional dissection of knowledge, engineering, and action into academic disciplines. Many of our most serious problems have arisen because narrowly conceived technological improvements have failed to take account of side effects, deleterious or otherwise, which inevitably accompany a widespread technological change in society. The question then, for universities, is how to pursue multi-disciplinary education, multidisciplinary research, and a wide ranging discussion of our human problems irrespective of disciplinary

boundaries or professional descriptions. In a way, the use of the word "multidisciplinary" betrays the history of the problem. We are talking about the approach to and the solution for problems and not about the scientific disciplines which can bring to the problem some important knowledge or evidence.

Problem Focused Activity at Universities

In popular discussion of how to solve our environmental problems the space program or, less frequently, the success of our efforts to solve technical problems during World War II are cited as models. For the universities neither of these examples is particularly relevant; the World War II efforts were conducted under a suspension of the university "rules" in which everything was put aside in favor of this consuming effort with the idea that normalcy would return when the war was finished, as indeed it did for the most part. The space program has been primarily an effort of the Federal Government and industry with important, although modest, contributions from the universities. More appropriate examples of ways that universities may contribute to the solution of society's problems may be found in the areas of agriculture and public health. Although these problems are somewhat simpler than the complex problems surrounding the environment and the quality of life, these efforts, persisting for

fifty to one hundred years, are more nearly comparable to the kinds of problems we face in environmental quality. The schools of agriculture, established under the Land Grant College Act of 1862, have been successful in terms of their original purpose beyond anyone's wildest dreams. The schools of agriculture together with the agricultural experiment stations and the county agricultural agent program have increased agricultural productivity to the point where it, too, is a problem. The gains in public health to which the university schools of public health and medicine made important contributions are too well known to require recapitulation. What is perhaps most impressive is that these units of universities have always had reputations of being second rate intellectual efforts and, like all prophecies, repetition of such statements is self-fulfilling. That they succeeded in spite of this is a remarkable accomplishment. The common feature of both of these efforts is that they are problem focused.

It will not be easy to begin new problem focused programs at universities, despite the need for trained professionals and the seriousness of the problems. Dr. J. Kenneth Hare, Professor of Geography at the University of Toronto and former President of the University of British Columbia, commented on these difficulties in an open letter:

"Let me start, then, with the question of environmental studies in a modern University. We all know the conservative quality of such places, ..here nothing can easily be done for either the first or the last time. The status quo is defended in depth by the vested interests of a large number of able people. Among these interests are those of the traditional departments and the largely analytical disciplines they profess. Also strong are the numerous special institutes and centers that have got started in spite of the resistance of the departments. When we propose to start up a broad-spectrum, synthesizing effort like environmental studies we run full-tilt into all these vested interests.

"We also bang ourselves against the clan-spirit of the traditional faculty groupings. Humanists, social scientists, natural scientists, and professionals like lawyers and engineers may fight like cats within the clan, but they close ranks and hitch up their kilts when someone questions their loyalties. Environmental studies have to involve many of these clans, which are not used to combining in the way required. If we suggest, as I do, that some of them - notably the humanists - may be utterly transformed by such combinations we alarm the timid and anger the Tories among them.

"But the greatest hazard in our path is inherent in Lyndon Johnson's acid query 'Therefore, what?' which he threw at a group of professors who had just briefed him on the Middle Eastern situation. The political interest in the environment demands proposals for action - on all time scales, from the immediate assault on pollution problems and other festering sores of today, to the long-term reconstruction of society in a better relation with environment. At present we are not equipped to make such proposals. We are not action-oriented, and on every campus there is a dead-weight of opinion that regards action-oriented programs as hostile to the academic life....

"I must also stress the incompetence of the established disciplines to tackle society's real problem. What we mean by a discipline is an agreed tested body of method - usually analytical - that we bring to bear on problems of our own choosing. The essence of our thinking is that we cannot tackle problems that don't fit the competence of our own discipline. It's true that we constantly try to enlarge that competence. Confronted with a new problem, we spare no effort to improve our methods. But if we don't succeed, we don't tackle the problem, and we tend to condemn colleagues who try."

The Design of the Study

What Has Been Tried?

It is not the function of the Federal Government to order the universities to undertake specific programs. It is idle to pretend, however, that federal funding policies do not play a very large role in what happens and, equally important, what does not happen at universities. The response to various funding programs of the government in defense, space and a variety of other areas have caused universities to erect a wide variety of institutes, centers, and programs to respond to the available funds. In most cases these institutes have been largely paper structures and their impact on the universities and, especially, on the students and the public discussion of the issues surrounding the work has been negligible. Curriculum, faculty rewards, and most of the research has been controlled within the departments representing the narrow academic disciplines. These departments grow narrower and more numerous year by year as the advance of modern science results in increasing specialization. These institutes and centers contrast strongly with the history of agriculture and public health in which curriculum, faculty, and research were centered in schools that were nearly autonomous.

This study set out to examine the range of institutional arrangements that have been tried in dealing with environmental problems

and to determine, as nearly as possible, which kinds of arrangements have proven to be successful. We return at the end of the report to inquire how the government funding policies effect university work in the environmental area. It is important that funds made available to work on environment quality problems be supportive of those efforts likely to result in success, and equally important that they are not wasted on the kinds of efforts that have already proven to be unsuccessful. The urgent and long term needs to examine the quality of our environment and identify what alternative futures may be open to us suggest that a vigorous program comparable in vision to the Land Grant College Act would be extremely important if there were any chance whatever of success.

Society, through its government, does not deal in academic disciplines. It deals in problems and opportunities. Society has a right to expect, as a part of the educational process, discussion of the prominent issues, problems and opportunities of the day, and training of professionals who can deal with these problems on a professional level. A second function of the universities is a prominent role in the long range public discussion of alternative futures. Many of our government policies, now commonplace, have originated in academic discussions of an earlier generation. Yet, except for the doomsayers, discussion of possible future environments among the world's academic community is surprisingly muted. We do not have offered to us the variety of alternatives which may be possible,

takes place. As a result of proposals, awards are made.[1] At this point a decision must be made on where the integration of results is to take place. It may be that a strong agency technical staff feels capable of performing the integration, or it may be that the integration is left to the university. In either case certain problems can arise. The basic one is the "freezing" of subject area around the original rfp, the choice of which task may have been made by various routes. The choice can become obsolete very rapidly, but the response of the agency may be very slow. Universities, too, have not been overly responsive to the traditional rfp for various reasons. The agency writer of the rfp may not express his desired in terms the university investigator can understand. Further time limits are very difficult for universities to meet. The proposal lead time is frequently too short for the typical university to meet and the detailed checkpoints placed on various segments of the rfp do not recognize the nature of the university operation such as use of graduate students to assist in the research, etc., which make attainment of deadlines difficult indeed. These factors are recognized in the unsolicited proposal technique, but the interdisciplinary programs so developed appear to be more "after the fact" than real.

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[1] I include here, too, in spite of my category unsolicited proposals submitted as a result of avowed agency interest in a given subject area. For example, research in areas pertinent to the understanding of cancer takes place through unsolicited proposals, but only those proposals having some relevance to the cancer problem are funded.

Finally, the integration of results requires a strong agency staff, a condition which can lead to active competition for agency funds between the agency staff and the solicited (or unsolicited) contributors. On the other hand integration at the university implies a very deep understanding of agency intent--a condition difficult to attain when the rfp is written in semi-isolation from the university asked to perform the task.

Agency on-site Extensions

Various agencies have, from time to time, set up what amounts to an extension on or near a university campus. The size of the extension may range from one professional staff member to a complete laboratory staffed by civil service personnel. The aim of the extension's activity is fairly well defined, and well integrated with the mission of the agency. The desired result is to mingle with the university staff and its graduate students with agency staff in order that these university resources might be put to use in the pursuit of the mission. The university personnel are used on a hired basis for varying periods of time - a summer, a year, part time, etc. The results achieved are collected and packaged by the agency extension staff.

Considerable flexibility is available under this plan. For example, the employment procedure might involve a direct payment to the individual, payment to the university for part of a faculty member's

time, or the usual grant or contract administered at the local level. In short, the techniques that have been used have depended primarily on the ingenuity of the local management in the performance of the task.

There are difficulties in this arrangement too. What, in effect, is done is the supplying of a mangement structure aimed at carrying out interdisciplinary research, a management structure which it is supposed the university lacks. What might happen is the conflict of two structures, neither one of which has been fully developed on the college campus. Strangely, there seems to be considerable support for the establishment of such organizations on college campuses, and a feeling in the agencies that the existence of this sort of structure might interfere with the academic organizations.

The tendency of organizations to grow without good reason for growth has been noted as a drawback to the implementation of the concept, and once again the problem of creative monitoring comes to the fore. The agency management must distinguish between growth for growth's sake, or growth necessitated by greater understanding of the problems and possible solutions. The funding of such units also, most likely, involves interagency cooperation toward an overlapping goal, a difficult thing to achieve at best and particularly difficult in times of static budget.

Finally, we tried to examine the present participation of the government through its agencies or individuals in the interchange with the universities - faculty and students - in consideration of these environmental problems. The leavening effect of students and others participating in the government has been aptly demonstrated by the Executive Intern and White House Fellow programs. The contribution federal officials could make to the educational process of faculty and students at universities through brief participation there should not be overlooked, and the rejuvenation of a man from an operating agency worn down by long work on persistent and difficult problems should stimulate the agencies involved.

These are ambitious objectives for a brief study and we have not achieved them to our complete satisfaction. Nevertheless, in what follows we think we have reached some important conclusions. We consider time of the essence; therefore we urge that prompt action be considered and that the problems simply not be studied to death.

Institutions for Study

In order to examine more closely what has actually been tried at universities, we first attempted to ascertain which institutions had innovative programs. In this effort we were helped by a variety of people, but particular thanks are due to Mr. Richard Carpenter of the Legislative Reference Service who, with the kind agreement of Congressman Emilio Q. Daddario, made available to us the results of a mail survey of over two thousand colleges and universities in the United States. Of the large number of returns received from this questionnaire relating to programs in the environment, we examined about two hundred in detail which had been selected by the Legislative Reference Service as having some program or plans. This screening process enabled us to be reasonably certain that we had not neglected some very exciting and unusual programs. Subsequently we talked to faculty and/or administrators in multidisciplinary programs in more than thirty universities. Some of these programs and their institutional arrangements were quite interesting and almost all have their own special features.

We made site visits to the six universities. We do not feel that a larger number of site visits would have substantially

changed our conclusions at this time. In addition, we have talked at length with various officials of the Federal Government concerned with multidisciplinary programs including representatives of the National Science Foundation, the National Institutes of Health - Public Health Service, National Aeronautics and Space Administration, and the Department of Defense. We have talked with and received opinions from a variety of other non-government people, including representatives of the National Student Association, the Ford Foundation, RAND, the National Council on Education, and the Conservation Foundation. The opinions expressed by these many individuals and the written material which they have sent us have contributed to the formulation of our conclusions and ideas.

Results of the Study

Institutional Arrangements

At almost every university and at most colleges there is an incredible number and variety of interdisciplinary institutes, centers, and programs on almost every subject of human interest. At one major university we counted 157 such freestanding institutes and centers, and at another major university 126. While the rosters of these institutes and centers are frequently impressive, in reality

they most often focus around one or two men with an idea and an interest which gave birth to the center. Most of these institutes and centers have in common that they satisfy neither one of the criteria mentioned above -- that is, they have no influence over the faculty reward structure and little or no influence over curriculum. Research done under the auspices of institutes or centers is most frequently done within existing departments and it is only the sum of research that is interdisciplinary because each individual project is divided into the disciplines and pursued independently. This widespread and pervasive experience with the "paste-on" institutes is unimpressive, and it is clear that this kind of institutional arrangement simply does not work at universities if one wishes to educate new professionals, to involve students with the topical material, and to have free-ranging discussion across disciplinary boundaries take place.

Of the six programs we examined in detail, two of them had their origins in city planning and urban studies efforts, two of them had their origins in sanitary engineering and, to a lesser degree, civil engineering, one originated from a combination of biology, engineering and public health interests, and one grew from diverse sources mostly in engineering. Those programs having their origins

in engineering still exhibited a strong attachment to the engineering schools and had as their principal features strong science and engineering together with operations research and systems analysis efforts. Programs originating in urban studies contained a much larger element of social science involvement extending well beyond economics into psychology, sociology, and other areas. Several of the programs were connected with schools of public health and medical schools, although in most cases this is a somewhat uneasy relationship at present and no professional medical people seem to be directly involved with the program on a continuing basis. There were minor contributions to some programs from professional schools of public administration, law, and industrial relations. Most of the program leaders hoped for further involvement and indicated some enthusiasm on the part of the professional schools. Lack of funds was most often cited as the reason that the arrangements had not proceeded further. A disturbing note was the lack of humanists with these programs. Since perception of our environment is dependent so strongly on our ideas of aesthetics, social aspirations, and beliefs, it seems important that humanists be involved in consideration of the environment. Again, many program directors

felt this need and hoped to add humanists at a later date. Particularly when other countries are considered, it is essential that humanists be involved because foreign cultures frequently do notregard their environment in the same way that Western cultures do.

The formal institutional structures of these six programs differed considerably: one was a Center, one an Institute, one was a Program, one was a Department, one had no name but was centered around a department, and the least effective one had no name but included a center and involved members of several departments. What all of the effective programs shared were the two features mentioned above; they had substantial influence or complete control over faculty hiring and subsequent promotion and rewards, and considerable flexibility in introducing new course work and curricula, and flexible degree programs for students working in the problem areas. In most cases they also had the direct interest of one of the more senior administrators of the university who frequently had helped foster the program and who almost always helped to provide both resources and protection from traditionally minded faculty members.

It seemed obvious to us, and was mentioned by at least one of the program directors, that possession of their own resources and considerable influence in the faculty and curriculum areas made for a more harmonious relationship with the traditional departments and

schools of the university. When the program was in competition for the scarce resources of the university, the traditional departments were frequently arrayed in opposition to the problem focused programs or institutes. The departments of the traditional disciplines did not actively support these programs. There were individual participants from the departments interested in and actively participating in the programs, sometimes with part of their salary paid by the program and sometimes not. But there was almost a sense of conspiracy among these participants as if problem oriented programs were somehow at odds with the purposes of their discipline departments.

The physical plant provided for most of these efforts, except for that one which was a department, were generally makeshift and somewhat inferior and frequently scattered widely over the university campus. This was noted as troublesome. As many of the program directors pointed out, multidisciplinary efforts thrived best if the participants were in fact brought together on a regular basis so that they became accustomed to conversing with one another. One program at a major university had provided extensive quarters for its multidisciplinary effort but the program was sufficiently new that we did not elect to examine it in detail. No doubt the newness of the programs has, in some cases, prohibited any efforts to provide more

suitable accommodation in some central location. That the programs remain as vigorous as they are without central accommodations is a tribute to the strength of the ideas and the vigor of the participants.

These programs and efforts are problem focused efforts as contrasted with the discipline and methodology focus of most university departments. This has deep and comprehensive implications for education, for faculty, and for the ultimate goals of the educational institutions themselves. It is a mistake, however, to think that they are unprecedented. We have already cited as examples the schools of public health and the schools of agriculture. There are other analogies to be drawn to the professional schools of business, medicine, and law. At the universities we examined, the programs focused on a broad range of environmental matters, but within this general framework -- somewhat vague and all-embracing -- centers of intellectual activity grew up around the interests and abilities of the people who were there. This is appropriate and it would be a mistake to try and mold all these institutions toward some particular purpose. Any hope of eventual success in solving our problems in environmental quality requires a great variety of specific problem focus, style of activity. The institutions at which such efforts are mounted may require somewhat different specific institutional arrangements.

We came to conclude only that problem focused efforts have an appropriate place in education, that the places we visited were vigorous and promising, and that the two criteria mentioned above are essential for any hope of success even though they cannot guarantee it.

In the course of our study we had an opportunity to examine a report by Eric Jantsch of the OECD entitled "The Emerging Role of the University." This study was prepared during a year-long stay at the Massachusetts Institute of Technology and represents considerable study and conversation about the future of American universities. We found this study to be particularly thought-provoking and agree with many of its conclusions. In terms of institutional arrangements, the following comments by Jantsch are indicative of what we felt to reflect the motivation and aims of the best programs we have seen in operation:

> "We are living in a world of change, voluntary change as well as change brought about by mounting pressures outside our control. Gradually, we are learning to distinguish between them. We engineer change voluntarily by pursuing growth targets along lines of policy and action which tend to rigidify and thereby preserve the structures inherent in our social systems and their institutions. We do not, in general, really try to change the systems themselves. However, the very nature of our conservative, linear action for change puts increasing pressure for structural change on the systems, and in particular, on institutional patterns.
>
> "We are baffled by the sudden appearance of such pressures for change in the educational system, by student unrest, and by the notion that the current type of education may no longer be relevant. We are confused by the degrading side-effects of technology on the

systems of human living, in the cities as well as within the natural environment. And we are ridden with doubts about the effectiveness of decisionmaking processes dominated by short-range and linear thinking and about the piecemeal and passive way in which scientists and engineers respond to them. Through its three functions -- education, research, and service -- the university is deeply affected by all of these pressures for change. To live with them, to absorb them and even make use of them, requires a new purpose and a new structure for the university.

"Throughout this paper, the belief is held and substantiated that the disruptive forces threatening the university -- and, indeed, society itself -- may be expected to act as cohesive forces once a number of structural changes have been introduced, both within the university and in its relationships with society at large and with the various elements of the surrounding community.

"It is necessary to deal with causes, not with symptoms. The general concern over the university, and above all the students' concern cannot be resolved with patchwork and compromising, shock-absorbing strategies. There are no clear-cut problems to be solved -- the classical single-track and sequential problem-solving approach itself becomes meaningless today. This may come as a cultural shock to our pragmatic and efficient society, valuing nothing higher than 'know-how'."

Faculty

We talked to a great many faculty members at the six universities we visited and a good many others in Washington. It became obvious that there was a fundamental difference in career goals between those associated with problem oriented programs and the more traditional faculty devoted to disciplines. One man with particular technical preparation may choose to devote himself to the uncovering of new knowledge in the traditional academic mold and the improvement

of his discipline while another man with precisely the same preparation may devote himself to a broad problem area. This difference of attitude is institutionalized in a traditional academic department so that, even though individual members may have interests in problem areas, the sum of the department has a strong vested interest in preserving the study of the discipline, the improvement of methodology, and the pursuit of new knowledge wherever it may lead.

Basic research is not a continuous process but rather a continuous succession of choices. Will I follow this direction or some other direction? A problem focused man will take that direction which he expects, rightly or wrongly, will lead closer to the solution of problems in which he is interested, whereas the man devoted to the uncovering of new knowledge will take that direction which he finds most interesting. As scientific knowledge accumulates and academic disciplines fractionate into ever narrower professional specialities the institutionalized differences between these two fundamental attitudes become clearer and more irreconcilable than ever. Several faculty members we met emphasized this basic difference in career goals. When problem focused programs were clearly separated institutionally from those with discipline goals the faculties got along better, talked more freely together, and even worked together on some specific topics. The uneasy

relationship which exists between the two goals is clear from hiring practices. If the chairman of a discipline oriented department is faced with the choice of two men, one with a problem focus and considerable experience, and the other with a narrow disciplinary orientation and much accomplishment in basic research in his specialty, the chairman will invariably choose the latter.

The traditional rewards of the academic profession have been most commonly given to those with a discipline orientation and perhaps this is appropriate. We found that the faculty with a problem focus were not especially concerned about this kind of academic standing and reward structure; but for obvious reasons they were conscious of the university reward structure including appointment, promotion, tenure, and salary levels. There may well be some men who would like to pursue both kinds of activity; however we are skeptical that either activity can survive unless it has a corps of dedicated people clearly identified with it and who recognize one or the other as their home base.

Many of the faculty members associated with these problem focused programs have had experience in government, in industry, or in other service activities. This contact seems especially valuable and ought to be encouraged by any such programs that are initiated. Outside

people who came in as instructors from time to time seemed also to be useful. In one such program the mayor of a major city was coming to learn as well as teach in the program.

Those faculty associated with the problem focused programs numbered more engineers among their members than any other collection of professions, although there were biologists, physicians, economists and other social scientists, and a sprinkling of professional people such as lawyers in some programs. In our opinion most of these people were extremely able. Many of them are among the leaders in their field. In some cases this could be ascertained by their academic standing in their disciplines at the time they elected to engage more strongly in problem focused work. In other cases the evidences were practical ones. For example, one man was actively pursuing game theory as a method of discovering how different groups in the society thought government policy was made. The evidence of his ability in the field was that an incredible variety of city and local government agencies (and 26 foreign countries) have attempted to hire him as an advisor. He now has to decline most such invitations because he simply does not have time to pursue his own work nor his interests in educating his students. Other similar

examples could be cited. The programs that had been going for some length of time seemed to attract considerable project support from industry and government at state and local levels. This is direct market place evidence of the success of these programs. It would be a mistake however to attempt to run programs permanently on specific project support if, as we believe, the society as a whole has an interest in the educational aspect and the free discussion aspect which are not served by the short term problem focus usually supported by industry and local governments.

Problem focused work is admittedly difficult. It requires multi-disciplinary efforts or, as one student put it, "adisciplinary." A number of impediments were proposed to us from time to time by discipline oriented faculty. For example, it was suggested that faculty will work across disciplinary lines on projects if money is available. While it is true that in times of tight money supply faculty may look eagerly toward any moneys that are available, it is not true that one can simply bring members of different disciplines together and immediately expect successful joint efforts. The most successful efforts were among men who had spent some considerable time working together.

Those trained to different disciplines develop a collection of technical terms, ways of approaching problems, and analytical tools

which differ more in description than in substance. In the most successful programs a common language had developed after some length of time. However the language problem was solved, it was not solved instantaneously by bringing together a variety of disciplines. After a core group has developed a common language it is much easier to bring in an occasional visitor from some relevant discipline who can, in effect, have the proceedings of the group translated for him until such time as he understands how they communicate with one another. The students who participate in such programs have less difficulty since they begin with a multidisciplinary approach.

Another common allegation was that the faculty would get out of date in such a program. There is some evidence that in the case of the schools of public health some faculty did fall behind the advances of relevant disciplinary fields. One cannot guarantee that this will not recur. We can only state that we found the participants in these environmental quality programs fully up to date with developments in the disciplines with which we were familiar. In areas such as systems research, game theory, and computer techniques the faculty were developing new methods. In any case, there is no reason why, given satisfactory institutional separation between the people dedicated

to problem solving and those dedicated to basic research, a peaceful interaction cannot take place in which both groups stay up to date and are stimulated by each other. This kind of symbiotic relationship was developing at several of the institutions we visited.

Finally, several famous members of the scientific elite have suggested that there is not a supply of able people willing to engage in activities of this kind. We have simply not found this to be true. There are far more people willing to engage in this activity than can find support either to teach, do research, or work on problem focused activity related to environmental quality. It is interesting to note that we have received several unsolicited resumes from young scientists at three of our leading universities who have heard of our summer study and wish to be brought to notice of those programs where they might secure jobs in this area. The resumes of these young men suggest that they are among the very brightest available from physics, molecular biology and other fields.

In summary the faculty seemed well qualified. The supply is abundant for an expansion of ten times or a hundred times the present level of activity. What is lacking is an institutional willingness to try and, most of all, there is a shortage of money with which to start. We will return to this subject in the findings and recommendations.

Students

One of the myths, often repeated when discussing interdisciplinary programs, is that if students do not have the proper disciplinary training they will not be prepared for careers awaiting them in the "real world." The students with whom we spoke disagreed. As stated in the Cox report on the Columbia disturbances:

> "The simple fact is that a constantly growing proportion of the best students does not look forward to careers molded along the established lines of professional or business success. The point can be proved statistically, but it is enough to illustrate it by reference to the tremendous interest and social service work in the Peace Corps and conversely to the difficulties established business firms and the professional advisors now face in recruiting."

The world to which the PhD student is headed is one concerned with problems, and not organized along disciplinary lines. There is a variety of jobs awaiting such a problem oriented student. For example, there are numerous government agencies currently faced with an alarming lack of trained individuals who can competently deal with problems of the environment. At best, we have managers trained in a discipline and with a tendency to view all problems that come under the auspices of their agencies in terms of that discipline. There will always be agencies and industries interested in hiring people to solve problems. The Vice Presidents for Research of two major corporations told us that they desperately need people with broad training in the environment. What better source of manpower, than those who have been trained for just this purpose?

It is even possible that this is a moot question. For more and more today, we find that students are less interested in the material values than their parents. We have spawned a generation with a "social conscience." Unlike their parents, this generation was raised without the devil of depression in constant watch. Many are not concerned with the security of a high paying job. Instead, they have found that what is most important to them is to divert the world from what they see as a path toward certain doom. That, in the student's view, the accepted academic disciplines have not met this need is evidenced by the findings of Dr. Benson Snyder, a psychiatrist at MIT. He has reported that a large fraction of the very brightest graduate students admitted to a scientific education either drop out or are much dissatisfied with educational goals. From performance data and in-depth interviews he concludes that these are not only among the brightest students but constitute those with the greatest depth of concern about society's problems.

Society is tragically unconcerned about these students who choose to drop out, yet these students' motives are closely related to the causes of campus unrest about which society is so alarmed. We would do well to question the genesis of such unrest. The twenty-two Republican Congressmen did just this and came up

with some surprising answers. They quoted one university student as saying, "Most of them (the faculty) hold to the ideal that the university is a neutral institution, devoted to objective truth. But the people who have power in America have pervaded this institution. The university could never be neutral in our present society... The university ought to be a partisan of the progressive forces in society." The Congressmen when on to state as one of their findings:

> "The student's view is an obvious departure from the generally held public view of a university as an isolated tower that transmits and enlarges knowledge in the process of preparing individuals for careers. This student's opinion requires that the university be relevant to our era and its problems, that it be committed to an active role as progressive force. What is important about this perspective is that it is expounded not by a minority of revolutionaries but by very large numbers of sincere and highly motivated young people."

They found that with each example of the university's inability to meet legitimate demands for change more and more students gravitated toward the radical students' point of view.

If the universities could overcome their innate conservatism by creating curricula which the students would find more relevant to the problems existing in the world outside the universities, then it is possible that a good deal of unrest on the campus would vanish. At least the students with a legitimate concern toward their education

would find that the university would indeed allow them to go into fields of deep social concern. We found evidence of this at all the campuses we visited. Almost all the students with whom we spoke were products at the undergraduate level (and many at the Masters level) of a strict academic discipline. Each of them has expressed a degree of dissatisfaction with his narrow disciplinary training. They were enthusiastic about the programs in which they were participating and expressed concern at the lack of such programs at other colleges and universities in the United States. None of these students worried about future careers. In many instances they voiced the desire to teach at the university level in programs of this kind.

It is of particular interest that a majority of the students with whom we spoke had had some experience in the "real world." Some had returned to the university after as long as fifteen years. At one such university with a program in city and regional planning, a new PhD student this fall will be the former Model Cities director of the neighboring large city who will be entering the program at the age of 50. These experienced students expressed little concern over their future. They had been working on society's problems and had come back after a realization that they needed problem-oriented training.

They felt, to a large extent, that their disciplinary training had been inadequate in preparing them to deal with problems outside the university.

In many cases students provide the cohesion for the group which the faculty are unable to contribute. The programs in which the students had a strong voice in direction and goals seemed to work the best. It was the students that were truly inter-disciplinary. With their problem oriented viewpoint they provide an important channel of communication between the participating faculty members. Because it is the students' goal to receive a true multidisciplinary, problem oriented education, they often demand there be a maximum amount of interaction between faculty and students and faculty among themselves.

It was only if the program functioned as a degree granting institution that the student gained the maximum benefit. The problems of such a Center when it existed only to supplement the student's education in an academic discipline were severe. The students at a large Western private school with an urban oriented program complained that oftentimes they were not able to devote the amount of time they wished to programs of their Institute. This was because many of them, especially the Masters students for whom no degree is granted, were required to take courses to satisfy the established

curriculum of their discipline at the same time that they were participating in programs of the Institute. Because of the program's flexibility, which included lack of deadlines and examinations, the students were forced to devote more time to those courses required in their disciplines which have such deadlines. Any benefits from participation in such an Institute will almost certainly be negated if the student is forced to place his work at the Institute at the end of his list of academic priorities.

Of the three major roles of the university - education, research, and the ongoing discussion of problems - it is certainly the education of students with problem oriented training which is one of the most valuable results of a program concerned with environmental quality. The fear that a student trained in such a program will be amateur rather than a professional is not echoed by the students themselves. These students, especially those with extended work experience, know that it is not necessarily true that a generalist equals an amateur. The students expressed confidence in themselves and in their ability to find jobs after they had completed their university education. They were excited about their programs.

Curriculum

There is strong evidence in our findings that the programs which have control over their curriculum are the most successful. The optimal arrangement is one in which the program or center offers a degree to its participating students. When this is the case students will not find it necessary to satisfy the academic requirements in a department in addition to any which may be attached to the program. Some of the programs did offer their own degrees. Others overcame the problem by making use of the committee or individually planned degree. Thus, the students were able to devote their time to interdisciplinary programs concerned with the environment.

An Environmental Quality Program should have a mechanism through which courses may be created and added to the curriculum of the students. It is neither necessary, nor desirable, that the students' entire curriculum be offered under the auspices of the program. We are, after all, looking for interdisciplinary programs and the students should take advantage of the wide range of courses offered throughout the university. However, it will not be entirely answered by those courses already in existence. Many of the programs offered core seminars as the basis upon which the student built his curriculum. In one case, these core seminars served as a meeting ground for interaction between students and faculty. There was no

subject matter attached to the seminar until the faculty and students together decided what it should be. In all of the other programs students and faculty were free to create courses which they felt necessary for their education.

Whether or not a degree was offered, the students were allowed a wide range of freedom in deciding upon their curriculum within the programs. In the cases where degrees were offered, students were encouraged to tailormake their own curriculum, usually in conjunction with a faculty adviser. One student at a small eastern school commented that never in his educational experience did he feel, as he felt now, that his individual desires and talents were taken into consideration in formation of his degree program. It was at this same school that the students commented as a group on the absence of competition within the department. They explained that the range of problems dealing with the environment was so large that there was no reason for them to compete either for thesis topics or for jobs afterwards. They were excited by the individual freedom allowed them in the pursuit of their education.

As students often pointed out, absence of set requirements allowed them to take a wide range of courses throughout the university, thus giving them contact with the various disciplines. One student remarked

that the value she found in taking courses in other disciplines was that she was learning how to communicate with those people still lodged in disciplines. In no case did we find students who felt themselves unable to compete in these disciplinary courses. It is through this contact that the students become truly inter-disciplinary. Since they had become used to participating in courses across the academic spectrum, they had much less difficulty than the faculty attached to the programs in communicating across disciplinary lines.

There was some evidence that courses offered by such programs are taught differently than those offered in the traditional academic disciplines. Seminars and workshops were the common course structuring. But much more so than in the traditional disciplines, the seminars tended more toward group interaction and "T group" experiences. It was a feeling expressed many times by the students that they had little patience with faculty members who made rare appearances at the Center. To the extent that research was a part of their training the students welcomed it. But they stressed that they did not want a faculty member involved in the Center who was primarily interested in his own individual research and who spent most of his time on it. A faculty member heading an undergraduate

program in the urban area at a western private university felt that the pressure on him was much more than he had experienced in any other academic situation. The students demanded that he be present sometimes just as a sounding board for their ideas. He felt that many faculty members had a fear of this interaction and thus shied away from participation in such vigorous programs.

In particular, the students should have some practical experience in working out the problems of the "real world." Whether it be in an urban semester program or through a work-study program, this is experience that will be invaluable to the student once he has finished his studies. The university will always, to a certain extent, be insulated from society outside its boundaries. Only through the instigation of such work-study programs will students be allowed the experience of actual problem solving.

THE ROLE OF FEDERAL FUNDING

In considering the role of federal funding in environmental quality programs it is important that the Federal Government, and specifically those agencies concerned with problems of the environment, not fall into the trap of funding disasters and withholding money from those programs with the greatest chances for success. A common complaint we heard at all the universities we visited was that there was a general lack of funds available for such wide ranging interdisciplinary programs. What the heads of most of these institutes found themselves doing was going through a process of genteel lying and cheating in order to get money for their programs. Often times, it was necessary to emasculate the programs in order to suit the specifications for federal funding.

We have not attempted a detailed study and analysis of the Federal Government's past efforts to fund interdisciplinary research and education. Such study has been made by Dr. D. E. Cunningham under the auspices of NASA. At our request, Dr. Cunningham agreed to summarize his findings for this report and his summary is attached as appendix 1. His findings have helped shape our conclusions and recommendations.

The most common method of funding is through individual research grants or project grants. What the Federal Government is in effect doing is encouraging the creation of "paper institutes." The money, usually in the form of project grants, is awarded to the institute and each professor quickly takes his share and returns to his department for his individual research. After a certain length of time the professor may be expected to return with a neat paper of research results. This can hardly be considered as a satisfactory model for interdisciplinary research, and there is certainly no provision for the training of qualified individuals who will deal with environment or for the on-going discussion of environmental problems. In essence, the funding patterns are not demanding of any commitment by the institutions. Any interdisciplinary work which exists today is largely a result of sheer will on the parts of the participating individuals.

Another result of such funding patterns is that there is a lack of continuity, of research and of training. Once the project has been completed the faculty members working on it disband the group and seek new funding for new projects. Thus, the faculty members receive an excellent training on how to fill out federal funding applications.

One myth which has been built into the system of federal funding is that research and training can be adequately separated. Especially in these interdisciplinary areas this is just not the case. There have been a few training grants for individual students who wish to pursue particular projects. But how can they be trained in the area of environmental quality if there is no one on the faculty of the university to train them? These training grants force the student to identify himself with a particular academic discipline and often times he is diverted from his original purpose and the purpose for which the training grant was awarded.

The funding patterns as they exist today do not seem to promote an interaction between the funding agencies and the universities - an interaction which could prove to be rewarding for both. The students could receive valuable experience through contacts and work with agency officials. Especially if a program is to be problem focused students should be exposed to the problems with which the Federal Government is faced. Further, many agency officials could benefit from the new ideas which come out of the interdisciplinary programs in environmental quality.

There is a broad need for programmatic support for these environmental quality programs. The Federal Government must

attempt to select those programs which have the greatest chance of success. According to our findings, this would mean that the Federal Government should look for programs which have a strong hand in the faculty reward structure and over student curriculum. In addition, the agencies intending to do the funding would be wise to look for a strong administrator with some overall responsibility for the program. It is usually through the presence of such an administrator that the program has managed to establish itself within the university structure.

The Government could play an important role in the institution of these programs by contributing seed money for the hiring of faculty and for planning of new programs. Once the program has been in existence for specified length of time this money could be replaced by money from the university. But money, which is so desperately needed for the instigation of any such institute or program, will most likely have to come from the Federal Government since most universities cannot provide initial funding. If the program has a good faculty and a good plan of action, and if it can begin to attract students, then this is the recipe by which state and private sources will begin to divert money into the program.

It might also be wise for the Federal Government tc establish some policy regarding educational innovations in such programs.

Some educational money should be applied to these new interdisciplinary areas for experimentation with new methods of teaching and research. This would not be continuing funding but would provide for the preparation of new methods of teaching, course materials, and faculty free time to prepare innovations.

Student funding should not be ignored. The Federal Government and many industries are desperately in need of the people who will be trained by the program. It may well be that these people are as valuable to society as those in the medical sciences and perhaps the Federal Government should provide similar incentives and support for them. One common thread we found among the students in all the programs was that a majority of them returned to these programs after an extended amount of time of outside professional experience. Many of them had wives and children and were giving up lucrative jobs in order to return to the university. The Federal Government should consider funding support for such people. Continuing and re-education of such experienced people is in the best interest of society. Currently the amount of money they receive on training grants cannot adequately support them and their families. We do not want to preselect out those people who have valuable experience to contribute to the program. This is, in effect, what is happening

when we offer a graduate student with a wife and two children three thousand dollars a year. It is not necessary that such student support be only grants and loans. The work part of the work-study program could enable students in problem-oriented programs to earn much of their own way.

FINDINGS AND RECOMMENDATIONS

We conclude from the above that the problems are serious, that faculty and students are available for some new and imaginative efforts, and that present federal funding policy works in opposition to funding the kinds of efforts that seem to be successful.

We recommend that the Federal Government support formation of Schools of the Human Environment at colleges and universities. These programs should be expected to vary in their emphasis from university to university and from region to region. Their common purpose, however, should be problem-focused education and research directed toward people - their need and desire for a satisfying life in pleasant surroundings. Such schools or programs can begin the task of providing trained professionals to work on environmental problems, help to define what is possible and how to get it, and provide opportunities for the justifiable desire of many young people to devote their attention to environmental problems.

The Federal Government cannot start these efforts alone. Colleges and universities should exhibit their commitment to environmental programs with people and funds. In particular we recommend that such programs meet the following criteria:

(a) Substantial or complete control of the faculty reward structure and

(b) a relatively free hand to be innovative in introducing course material, educational programs, work-study programs and curriculum requirements for degrees.

(c) The focus of environmental programs should be expected to vary from institution to institution and the funding agencies should ascertain only that there is problem focus to the activity (whether technological forecasting, pollution abatement, urban planning, long range society planning, or a number of other continuing problems.)

We recommend that funding programs include at least the following items (but not necessarily be limited to them):

(a) Continuing core funding for the program as a whole. These funds should enable research and educational activities to go on at a modest level to be supplemented by project funding both from the government and from private sources.

(b) Seed money for faculty salaries is important since in the initial phases of the program private or state monies are not ordinarily available. As students become engaged in such programs these funds can be expected to be replaced by those from other sources. Institutions should indicate their willingness to seek such sources.

(c) Seed money for educational innovation. As we have tried to make clear above, new methods and techniques will be necessary to do problem focused education in somewhat different ways than that done in the traditional academic disciplines. It is important that educational materials, release time for faculty, and other expenses

be funded so that these innovative efforts can go forward as rapidly as possible. Funds for such innovation may already be available under programs authorized for the Office of Education, HEW.

2. We recommend that work-study programs for both faculty and students be a prominent part of environmental programs. In the effective programs currently underway it was obvious that the real life experiences of both faculty and students played an important part in their contributions to the programs and to the educational experiences of themselves and others. Since we are concerned with real-life problems it seems obvious, and was borne out by our study, that work-study programs are extremely useful. They are useful to the students as part of their education, to the faculty, in renewing their contacts with the actual problems, and should be of considerable use to the government by bringing in vigorous faculty and students for short periods and returning their own officials to the university both as students and as teachers.

3. Student educational support is essential as a part of environmental programs. While some training grants have been available under previously existing programs they are generally limited in scope and force students into different career patterns because of the lack of continuing programs that they can identify with.

Student support need not be in the form of grants or scholarships. Loan programs would be appropriate as would jobs at attractive rates of pay during the work part of work-study programs recommended above. We have concluded that reeducation of professionals from other disciplines or simply self-renewal of those practicing professionals related to the environment are a persistent need (see, for example, description of a man of fifty returning to one of the universities). For those undergoing reeducation or returning in mid-career higher support levels would be necessary since they customarily have families demanding more support than a single, young student.

4. Recommending funding levels. We have felt that the interest and the able professionals are available to expand the presently effective efforts by ten to a hundred times. We conclude that somewhere between ten and twenty major universities have programs sufficiently far enough along to be ready for funding. The cost of such a program depending on size and extent would range from two hundred thousand to about eight hundred thousand dollars per year including all the features mentioned above. In addition, we recommend planning grant support for some of the two hundred or more universities who have expressed vigorous interest in this area that are not sufficiently far along to offer a definite and fundable program. Such

planning grant support probably should be $50,000 or more for a one or two year period. Thus we recommend that approximately twenty million dollars be devoted to this program at the outset. Because certain aspects of the program should diminish in cost after the initial grants it is not likely that these funds need grow at a substantial rate in the first few years. It is our firm opinion that the government would get more return for its money in programs of this sort than they now get from some of the existing training grants and contract research. (See Dr. Cunningham's comments on this point in Appendix 1.) Therefore the recommended twenty million dollars does not need to be entirely new money. A crude estimate is that about one half would be new money and about one half could be diverted from existing funds expended under titles related to the environment.

Funding procedures should involve those agencies with a mission for problems of the environment. They should certainly include the Departments of Interior; Transportation; Housing and Urban Development; Health, Education, and Welfare; Commerce; and Agriculture. The National Science Foundation should fund programs that are not specifically a part of any agency responsibility but show promise for the future. The agencies mentioned have been notoriously ineffective (with a few exceptions) in funding institutional arrangements at universities. We therefore recommend funds be assigned by these

agencies to this program and that some senior people from these agencies be brought together under the policy guidance of the President's Environmental Quality Council with representatives of NSF, NASA, or DOD to take a lead role in the initial funding in a common effort embracing all the agencies. Eventually all the agency members should return to their own agencies to constitute a Bureau of Institutional Funding operating directly under the Secretary of the Department. Such a funding arrangement appears to answer most of the past difficulties pointed out in Appendix 1.

APPENDIX 1

FEDERAL ADMINISTRATION AND SUPPORT OF UNIVERSITY INTERDISCIPLINARY RESEARCH

by

D. E. Cunningham

Introduction

It is evident that the vital problems being recognized now, and which must be solved in the future, possess a degree of hitherto unknown complexity. To successfully solve those problems new approaches must be developed, approaches requiring use of coordinated and integrated disciplinary knowledge. As is always the case, trained manpower is needed to undertake the research necessary to achieve solutions to these pressing problems. The university as the producer of trained manpower and conductor of research must be involved and must respond to the challenge presented by the new problems--in fact, to produce adequately trained manpower the university must be deeply and actively involved in research, both basic and applied, in the vital areas of concern.

These complex problems are national in scope and so the federal and local governments have an abiding interest in their solutions. To a large extent this interest will be expressed through financial

interactions between government and universities and it must be recognized that it does matter in what form the financial interactions take place. It can, indeed, make the difference between progress in spite of the system, or progress because of the system. It is clear, too, that a single funding technique will not be appropriate for all approaches to the broad spectrum of problems--for as always, some problems are broader than others, and in some adherence to rigid time scale is required, others do not have the same requirements of immediacy. Implied here is that the funding technique used may need to change as research and development efforts reach different stages in the problem solution cycle. Administratively, this fact presents difficulties.

Various agencies of government have attempted to support multidisciplinary investigations during the past ten years. The effects of these efforts have been mixed. In particular, attempts to involve the disciplines of the social sciences with the science-oriented disciplines have been abject failures. The necessity for developing meaningful enterprises remains, though. Perhaps the reasons for failure are connected with the response time--that time which an institution takes to "react," or change--rather than with the approach. Perhaps it is a fact that the truly interdisciplinary

unit in a university is alien, at this time, to the discipline-oriented structure of the university. Perhaps the problems to be faced have not been defined precisely enough to allow an intelligent approach. Or, perhaps the problems so far encountered to not require the mobilization of resources across the board in order to achieve "satisfactory" solutions. There are other possibilities, almost as many as there are problems, universities, and pin points of federal interest and to be complete in their enunciation would be impossible.

What will be discussed in this paper are some of the administrative formats which have been used, why they have been attempted, what the pitfalls are, and to a limited extent an appraisal of the sort of problem whcih each might be expected to deal with most appropriately.

One further point should be made. This is that what is said here is said from the federal and/or state government point of view. It does not discuss the administrative match which should ideally occur at the university. It does not take into account the fact that the reward system for the individual faculty member at a university is almost totally ungeared to interdisciplinary activities. And it does not take into account the effect of many years of federal dealings and support aimed at that individual faculty member rather

than the university as a whole. This latter point cannot be emphasized too much since, if the government desires total university response, this response represents a total change in expectation to that which was cultivated in the past. It will take time to break this barrier, and breaking it will not be an easy task. (These points are dealt with in some detail in the main body of the report.)

Administrative Formats

There are at least seven distinct administrative techniques which have been used in the past years to fund and stimulate interdisciplinary research on the campus. All have features appropriate to particular problem solution. All also have drawbacks. Several of these techniques will be discussed in detail.

To establish a framework for discussion, the approaches so far used might be broken into the seven categories listed below.

1. Mission Oriented Block Grants
2. Institutional Grants (based on some formula)
3. Request for Proposal (RfP) Solicitation
4. Agency on-site Extensions
5. National Laboratory Involvement
6. Establishment of non-profits
7. Use of personnel through consultants, WAE (when actually employed), personal contracts, etc.

Each of the above has been developed in response to certain needs. How appropriate each, or all, is to studies of the broad problems of today is not well understood. Let us look at what the details of each type are.

Mission Oriented Block Grants

In this technique a university is asked to devise a theme which is in consonance with its mission oriented agency sponsor aims. The theme is surrounded by the contributions of individual faculty and the integration of the theme is performed at the university--generally by a committee. Funds go from the agency to the university where they are disbursed by action of the committee. In principle this sort of granting technique insures the cooperation of the university and the agency in pursuit of appropriate mission oriented research and training. Problems arise at both the university and agency sides, however. At the university the lack of a real management structure becomes evident. Fragmentation of funds, lack of educational involvement, communication difficulties both with the agency in question and within the faculty itself are some of the factors which result from this lack. On the agency side, problems of matching agency mission to the output of the university is particularly difficult. The results supplied, if they are worthwhile,

point the way toward the future. The value to the operational side of an agency is minimal since its concern must be frozen to some time in the past. It is not evident to the operating personnel of the agency how the block grant funds contribute to their future success, and they are sure they can spend the funds more wisely--and certainly they can from their point of view. The "middle men"--the administrators of these block grants at the agency--find themselves in a difficult situation and in a time of static or declining budget have little concrete to point to as the result of their programs.

Many agencies (NASA in the Sustaining University Program, DOD in Themis, etc.) have attempted this approach and the results have proven less than outstanding. Perhaps the universities were not ready for this type of funding, but perhaps they are now. Perhaps the real problems to be faced must be more delineated and the time to expected response be lengthened to correspond more with the typical delay times encountered in universities. What is evident, though, is that this technique has helped to produce some university groups capable of undertaking and performing interdisciplinary research--not enough, by any means, but some that do provide a possible base for expansion.

Factors of the dollar size of these grants in relation to their hoped for affect must also be considered. For example, of the cost of producing a single student with a PhD is of the order of $75,000, then the impact of a $100,000 grant or contract will not be large in an immediate sense. Further, how much agency effort can be expended in monitoring a $100,000 grant - certainly not an excessive amount and so coupling between agency and university suffers. There are many more considerations of this type, but the above are two of the most significant.

Institutional Grants Based on Formula

Here recognition is given to the fact that an institution performing research in some broad area, e.g. health research, incurs costs not covered by the sum total of individual grants and contracts it receives and further that, to be most effective, some "risk" capital to seed new research must be available. In order to supply funds of this type an agency may take as a base for an institutional grant some percentage of the total dollar amount of active grants and contracts, perhaps matching an initial amount of funds and then a decreasing percentage of dollar amount over that, and award funds in this fashion. The tacit understanding is that these funds will be used to develop further capability in broadly specified areas.

In this way the capability of an institution to function in these vital areas may be enhanced.

Unfortunately these grants suffer from three deficiencies. First, no indication of what the funds might be used for is required--no theme is established except in a very general way. Second, because there is quite clearly a crisis in the funding of higher education, such institutional grants tend to be spread out through the general funds of the university. This spreading might be defended as a way to benefit the educational institution and research on a broad basis, but it is definitely not as a stimulus for interdisciplinary research. Third, where there is a spending ceiling, as imposed by the National Science Foundation during the last two years, these institutional funds are the first not to be spent, since the internal pressures supplied by NSF-sponsored project investigators is intense in comparison with the desire to spend money for which there is, at best, a vague general plan for commitment.

Request for Proposal Solicitation (rfp)

The rfp is one of the classic forms of contractor solicitation. While usually not used in the performance of work of a more basic research type, there have been cases where it has been. Usually a broad task is defined in a particular area and the solicitation

and from which society and its elected representatives can select pieces to become part of our policy and national goals. The recent establishment of the President's Committee on National Goals is, in part, a recognition of this shortcoming. The increasing concern of the younger generation for the future quality of life in America suggests that the universities could play a very important, perhaps even a crucial part in such a wide ranging public discussion. Thus we certainly ought to inquire as to whether Federal funding policies could encourage this discussion forward and as a minimum ask that Federal funding policies do not discourage such discussion.

Criteria for Evaluation

What is it we expect of universities? Can education be all things to all people? How can one maintain rigorous standards? The universities can never respond to a crisis! An interdisciplinary education will sacrifice rigor! These questions and statements, whether from faculty, students, or ordinary citizens, commonly occur. Rather than try to answer them on intuitive grounds we set out to examine some institutions with on-going programs related to the environment and of multidisciplinary content to inquire how well they have worked.

It became obvious early in the study that two criteria were of significant interest when examining the ongoing programs related to the environment:

(1) The degree to which the program, center or other structure participated in the faculty reward structure - including appointment of faculty, promotion, salary, tenure, and other benefits afforded faculty members.

(2) The degree to which the program, center, or whatever participated in the generation of curricula, degree requirements and new or innovative approaches to education for these multidisciplinary problems.

If a program had no influence over either of these areas we found it to be ineffective and powerless within the university. Its contribution to education and public discussion was very limited even though significant research might have been done by faculty members. We also examined the relationship of such programs to real world problems (through work-study programs or other mechanisms) and the degree of participation by students educationally, in research, and in the formulation of policy for the program.

One further word about students is in order. Unrest on the campus has been forcefully brought home to us by the newspapers and television, yet those of us beyond student age still have some difficulty in understanding exactly what is happening on the university campuses. The problem is a complex one, but the following comment by the twenty-two Republican Congressmen who visited fifty campuses

during the spring of 1969 briefly summarizes the nature of the problem:

> "We came away from our campus tour both alarmed and encouraged. We were alarmed to discover that this problem is far deeper and far more urgent than most realize, and that it goes far beyond the efforts of organized revolutionaries.... Too often, however we saw their idealism and concern vented in aimless or destructive ways."

No reasonable man countenances violence. Nevertheless, direct attempts to suppress violence are dealing with symptoms, not causes. Society must respond to the searching questions students are asking. Prominent among these are the concern about the environment and the quality of life. A concrete way that the government can express its agreement about the seriousness of environmental problems is to do what it can to encourage students to work on these problems. We certainly desperately need qualified professional people who can help us solve the serious problems besetting our physical environment. The Republican Congressmen again state:

> "We found an encouraging desire on the part of many students to do something to help overcome the problems of our society. This dedication or commitment to help others is a hopeful, important area which should be encouraged."

In the discussion and recommendations that follow we have tried, by talking directly to students in environmental programs, to determine their reaction to these programs and to obtain some idea whether, in addition to being effective, these programs answer the deep and justifiable wish of the students to help in the solution of our problems.

What the academics see good about this scheme can be briefly stated as the lessening of pressures to change universities in short periods of time while at the same time allowing a university response to the vital problems of the day. The approaches that are effective might be absorbed into the university structure itself, after the period of test.

National Laboratory Involvement

The various national laboratories are certainly a potential resource in the general development of means to cope with the new problems. They contain talent, equipment, and resources which could be of great importance in contributions to efforts of the next ten years. There are, however, many problems inherent in the structure of national laboratories which make their use very difficult.

First, national laboratories are usually funded primarily by a single agency and hence their mission is closely allied with that agency's mission. This is as it should be, but to now concentrate on broader problems which overlap individual agency responsibility requires means of coordination which do not exist at present. We can talk as much as we want, but unless (at the working level) it is realized that there is joint responsibility for carrying out broad programs, those programs will not be carried out.

Secondly, national laboratories have usually been set up because the equipment and resources they possess are unique--generally too expensive in acquisition cost, and too expensive in updating and upkeep for a single university to finance. They then offer special facilities which may be used on demand by visitors. The visitors may receive support in a variety of ways as before - direct, thru his university, or by a grant or contract. In order to keep abreast of what is going on, a staff of high quality must be in residence, a staff which has interests in these areas in which possession of the highly specialized equipment is vital. In the face of this history, it is not at all evident that the analysis of the problems we will face in the next decade will require sophisticated equipment of this type, nor for that matter the deep specialization that characterizes fundamental research in the national sciences. In short, the historic mission has dictated the personnel requirements, the requirements have resulted in acquisition of the personnel, and the personnel do not have interests and skills readily transferrable to investigations of the type we need.

Note, though, that this same argument can be applied to the universities of today and does not imply at all that the national laboratories should not be of enormous use in the future. What is

does imply is that methods akin to those necessary to channel the university must be created, which will allow the resources to come to bear. In the same sense as a university is an institution, so is a national laboratory and what is needed are means and the desire to change institutions.

Some laboratories have made progress toward developing a capability to study and interest in studying the broad problems referred to above. AEC laboratories have been allowed to conduct non-AEC related research and development since 1961. At present the Oak Ridge National Laboratory does 14% of its research under sponsorship of agencies other than the AEC. This laboratory is, however, an exception even within the AEC structure since Argonne and Brookhaven, for example, have less than 1% of their efforts funded by other than the AEC.

Establishment of Non-Profits.

A non-profit, located near a university or universities can function in the same manner as the federal laboratory extension. The difference is that a direct line of authority to the agency in question no longer exists. The mission is defined, the university resources are utilized, faculty staff and students participate in the program of the non-profit. It is more isolated from the central

agency than the on-site agency extension, of course. The insulation offered by the non-profit establishment can have both good and bad values. When the insulation leads to an ability to view problems in broader perspective and over longer time periods, then this feature is a good one. When the insulation adds barriers to direct communication with the agency and with the universities then the non-profit does not serve its purpose.

Another drawback which may become evident as time passes is that the non-profit may actually compound the management problem. It can occur that an organization set up to supply management of university resources toward an established goal may actually come in conflict with the academic process through lack of understanding of the academic environment, or through its recognized and avowed aim of bypassing. What occurs in that case is certainly not conducive to the performance of any mission.

Aside from the obvious problem many the same comments might be made about the non-profit as have hitherto been made about the on-site agency extension. The non-profit can potentially allow greater freedom to perform the mission, due to its separation, but in its separation it may become less responsive to agency mission. This need not be a deficiency in the technique, since frequently long term and short term missions differ and an agent acting in the long

term sense may actually be more responsive to the real needs of an agency than one which is actuated by day to day demands. To phrase it another way - it is the problem's solution which is important not the agency's interpretation of the problem.

Use of Personnel.

This is perhaps the oldest form of administrative technique used to perform specific tasks. Consultants, use of WAE (when actually employed) personnel, small contracts for individual services have been utilized to achieve the specific goals which have been previously defined by an agency. In general this technique is best used where there is an internal agency competence which is capable of selecting the goal and integrating the results purchased from the individuals involved into the overall program. It does not work in cases where the goal is relatively undefined or where there is no good structure or ability at the agency level to assimilate the results. Further, this technique does not bring large scale interchange of information at a level deep enough to cause and allow constant reassessment of goals - a necessity if the large scale, less well defined and more complex problems of the future are to be solved. The mechanism is useful, but most likely will achieve its maximum effects in conjunction with the various other techniques previously discussed.

General Comments.

The foregoing has been a brief discussion of the various modes so far used by government to stimulate and support interdisciplinary research. Each technique blends into the other at some point, and each has its best region of applicability. A few words should be said about general problems inherent in the undertaking of interdisciplinary research independent of what particular administrative funding technique is used.

It has been recognized that the problems to be encountered in the next decade are problems which will involve the participation of many disciplines. This fact connotes team approaches, or at least team coordination in the approach, or analysis if there is to be any hope of success. Just as the disciplines must overlap, it must be recognized that there will most probably be agency overlap since agencies themselves have arisen and grown along discipline-oriented lines. This means a coordination of federal agency approach will be necessary. Coordination of approach is difficult in good budgetary times and grows increasingly more difficult in times of decreasing budget.

It appears that groups like FICE or CASE cannot accomplish this coordination since they are groups essentially without mission-oriented direction and without the ultimate power to require coordination on big things rather than small. Only agency administration or those in top echelons can give agency positions, or

conversely even bring the serious policy questions to the attention of their own agency for consideration. Some representatives at these levels attend and follow through on meetings of these groups, but in general the representation is distributed over various management levels including, of course, management levels that have day-to-day responsibilities which preclude active follow through.

Further, it is recognized that where goals are set, we can accomplish those goals by careful planning, we cannot plan and coordinate an interdisciplinary effort unless a goal is set. Great haziness exists on what should be the priority of goals, and we find ourselves in a position where we have very little of the data necessary even to make informed opinions on this question. Goal setting need not always be global but goal setting in at least some limited sense must be attempted. As long as the scope of goal setting is kept reasonably small, and the experiments in implementation reasonably small, we will at least generate the data on which to make decisions.

Further, what we are facing is a situation where we have resources in depth, but not in breadth. This characterizes the situation at the university, in the national laboratory, and in the government. What is needed is the mechanism to bring these

in depth resources to bear, to finance the effort, and to make use of the results. This requires a close coupling of management with problem analysis, and since it is apparent that this coupling has not been successful in the past, we should experiment, but with some idea of what we are experimenting to achieve.

Other items should be noted in passing. The cost of producing a Ph. D. is not universally agreed on, but it is in the range of $75,000 per (see Mission Granted Block Grants). With this fact in mind it is evident that grants of the order of $100 K to $300 K or so can only serve a "tickler" function-- they can only be superimposed on something already existing. While the focus of what is being done might be somewhat changed, deep changes will not take place in the short run. If, however, the grant is maintained over a long period of time, say five to ten years, the focusing effect will probably cause changes because of the fact of hiring policies' being influenced by the focus. Thus, changes cannot be expected in short time unless the federal commitment is large. Largeness, though, is not an easy way of assuring desired effects. Very few universities can accept a large grant or contract on a "new" area and absorb the activity undertaken into the academic structure - rather than adjacent to it. If it is adjacent, it most likely will not involve faculty and students, but rather will develop resembling

more a neighboring non-profit than an integral part of the university. Careful planning to assure involvement with the university is necessary--if possible development of an academic base for the activity. It could be that this will require a new "function oriented" academic department. Departments are not created overnight and so the pressure of funds, if present in sizable quantities, may actually be counter productive over the long run to the avowed purpose of getting the university as a whole and as a unit involved in the solution of and training for the problems of the future.

The problem of meaningful evaluation of the effects and outputs of interdisciplinary grants has been mentioned. Not only does this involve the question of who is to do the evaluation, but it is also one of how a program rather than a project is evaluated. One manifestation of this is the relative value of having a good participant in a project located across the hall versus an excellent contributor two thousand miles away. A strict project review would point toward using the excellent contributor while a program review might indicate the opposite. In either case, the hitherto firm basis on which proposals are judged - that of excellence has, at least been challenged.

Many other factors could and should be considered before coming to firm decisions as to whether there is a best way to stimulate,

administer and support interdisciplinary research. For example, is the purpose of the grant to "seed" new areas, or is it to expand capability in an existing area. If it is a "seed" grant, how is the transition made to any other form, assuming the seeding is successful. Should there be time limits (3 years, five years or some other time placed on such grants? If so, what mechanisms will be provided by the government and by the universities to assure continued support for good projects after the time limit has expired? If a university group succeeds in developing an interdisciplinary capability and outlook, it also will outgrow the sponsorship of a given agency. Thus, to continue its work it will require coordinated multiagency support, a goal difficult of attainment.

What is clear is that many approaches have been attempted. Little quantitative data exists as to the success of the various attempts. Little experimentation has been attempted to determine the range of applicability of each approach in terms of agency character and competence, agency resources available for interdisciplinary research, and agency definition of problems. We need to develop this data if we wish to plan administrative and funding techniques appropriate to the problem. Such data will

only be derived through experimentation by the agencies and evaluation of results achieved by various approaches to segments of the same or similar programs. In short, what is vitally needed is a quantitative study of the effects of agency administrative structure on the stimulation and output of interdisciplinary research.

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